STATE OF ALASKA

Jay S. Hammond, Governor

Annual Performance Report for

A STUDY OF A TYPICAL SPRING-FED STREAM OF INTERIOR ALASKA

by

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ABSTRACT

The Delta Clearwater River from Mile 17 to the mouth was sampled with an electrofishing boat in the sixth year of a project to monitor existing stocks of Arctic grayling, Thymallus arcticus (Pallas), and round whitefish, Prosopium cylindraceum (Pallas). Comparisons of relative abundance with like sampling in 1973 and from 1975 through 1979 are presented. The relative capture rate of grayling was the highest recorded to date, while that of round whitefish was the lowest.

Age class compositions from index sampling are compared with those from previous years' sampling efforts. Recruitment strengths are presented for various year classes. The 1975 year class, poorly represented in 1979, was predominant in 1980 but was followed closely by the 1974 year class.

Similar sampling was conducted on the Richardson Clearwater River. Age, length, and capture rate are discussed and compared with like sampling in previous years and with the Delta Clearwater sample.

A creel census was conducted on the Delta Clearwater River from May 9, to September 1, 1980. The catch rate based on completed trips was 0.70 grayling per hour, the highest recorded since 1953. Estimated pressure was 8,248 angler hours and harvest was 5,878 grayling and both represented the second year of a decline from a high in 1978.

A voluntary creel census for summer residents was conducted on the Richardson Clearwater River. Thirty-nine percent of the resident households responded at the end of the season. They expended 274 angler hours to harvest 387 grayling, a catch rate of 1.42 grayling per hour.

A total of 545 grayling and 280 round whitefish was captured at Mile One Slough during spring monitoring and represented the lowest catch since 1976. Composition changes in the catches of both species noted during the past years are discussed. Rate of in-migration as indexed by trap catches of both species during 4 years of monitoring can be correlated with water temperature.

A limited mark and recapture experiment was conducted to gauge the percentage of in-migrating grayling captured at Mile One Slough. Captures of marked fish at three upstream locations averaged 7 percent.

Clear Creek, a small spring-fed stream was surveyed in July. Fish presence was restricted to its lower reaches and consisted entirely of grayling. Age compositions are compared with 2 previous years of sampling and show that predominantly subadult grayling utilize the creek. Comparisons are drawn with the larger spring-fed systems, the Delta and Richardson Clearwaters.

Stock enhancement through the stocking of pond-reared grayling into the Delta Clearwater River system was assessed. Scale analysis of Age II-V grayling captured during spring-monitoring showed a 31 percent contribution to total catch. Similar analysis of grayling scales collected during index and creel sampling showed contributions of 29 and 31 percent, respectively.

Results of early spring fyke trapping at Spring #3, an area routinely stocked with grayling in previous years, and seining at Remington Spring, an unstocked area, showed a decided in-migration of both enhancement and wild grayling.

Tag returns from 651 Age I grayling stocked in 1979 are discussed and comparisons made with previous tagging studies. An estimated 40% returned to the system.

The analysis of scale pattern variables from samples drawn from three local spawning streams are presented and discussed as a means of determining the stock origins of grayling utilizing spring-fed systems. Significant differences were found for group means only during the first 3 years of growth.

Length frequencies, age compositions, and sex ratios of grayling sampled in the post-spawning migration out of Caribou Creek (Shaw Creek drainage) and the Volkmar River are presented. Total grayling tagged in Caribou Creek was 1,291, of which 75 were recovered during routine monitoring throughout the season. Of all returns, 83 percent were captured in the Richardson Clearwater River. Total grayling tagged in the Volkmar River was 112 with all nine recoveries captured in the Delta Clearwater. Comparisons of sampling data among these spawning streams and the spring-fed systems show similarities that support the tagging data.

Escapement counts of coho salmon, Oncorhynchus kisutch (Walbaum), into the Delta Clearwater River and Clearwater Lake outlet were made in October.

BACKGROUND

Studies of typical Interior Alaska spring-fed streams were initiated in 1952 by the U.S. Fish and Wildlife Service as part of the Arctic grayling life history study in the Tanana River drainage. From 1952 to 1958 investigations were conducted on age and growth, food and spawning habits, migrations of grayling and angler success. The study emphasized creel censusing and migration habits. The latter established several general trends of grayling migratory behavior. Results of these studies were presented as Quarterly Progress Reports of Federal Aid in Fish Restoration, F-1-R-1 to F-1-R-8.

From 1959 to 1966 studies of spring-fed streams centered on the Delta Clearwater River and were divided into the determination of stocks, migrations (interstream and intrastream) and angler success. They included the nearby drainages (Fig. 1) of the Richardson Clearwater River, Shaw Creek, and Goodpaster River, but with emphasis on the latter. The studies narrowed the generalities of grayling migratory behavior found in the earlier studies. They documented the homing instincts of grayling in their use of the spring-fed streams as summer feeding areas and the role of the Goodpaster River as a source of recruitment. The results of these studies are published in the annual Department of Fish and Game Federal Aid in Fish Restoration Reports, Volumes 2 through 7.

A 1973 study brought to date information on the status of fish species present in the Delta and Richardson Clearwater Rivers. Pearse (1974) provided life history information regarding length frequencies and distribution, length-weight relationships, condition factors, age and sex composition and maturity for Arctic grayling and round whitefish. Estimates of abundance and standing crop for both species were also made.

Annual work since 1975 has centered on the Delta Clearwater River with the monitoring of its grayling and round whitefish populations and the assessment of an experimental program for enhancing the grayling population by transplanting pond-reared fingerlings. Comparative population monitoring has been conducted on the Richardson Clearwater River since 1977. Investigations of local spawning streams and the post-spawning migration of their grayling populations were begun in 1979 to determine the relative importance of each to the recruitment to the above spring-fed stream populations.

Additional information on the Delta Clearwater River is contained in baseline studies conducted between 1978 and 1980 in response to large scale agricultural development in the area. Individual reports on water quality and benthic investigations, chlorinated organics, and geohydrology of the area are on file with the Alaska Department of Natural Resources, North Central District, Division of Forest, Land and Water Management.

The Delta Clearwater River is located approximately 8 mi northeast of Delta Junction. The main channel of the river is approximately 20 mi in length and the north fork is about 6 mi in length. The river drains an area of approximately 350 sq mi, draining heavily on groundwater as its source.

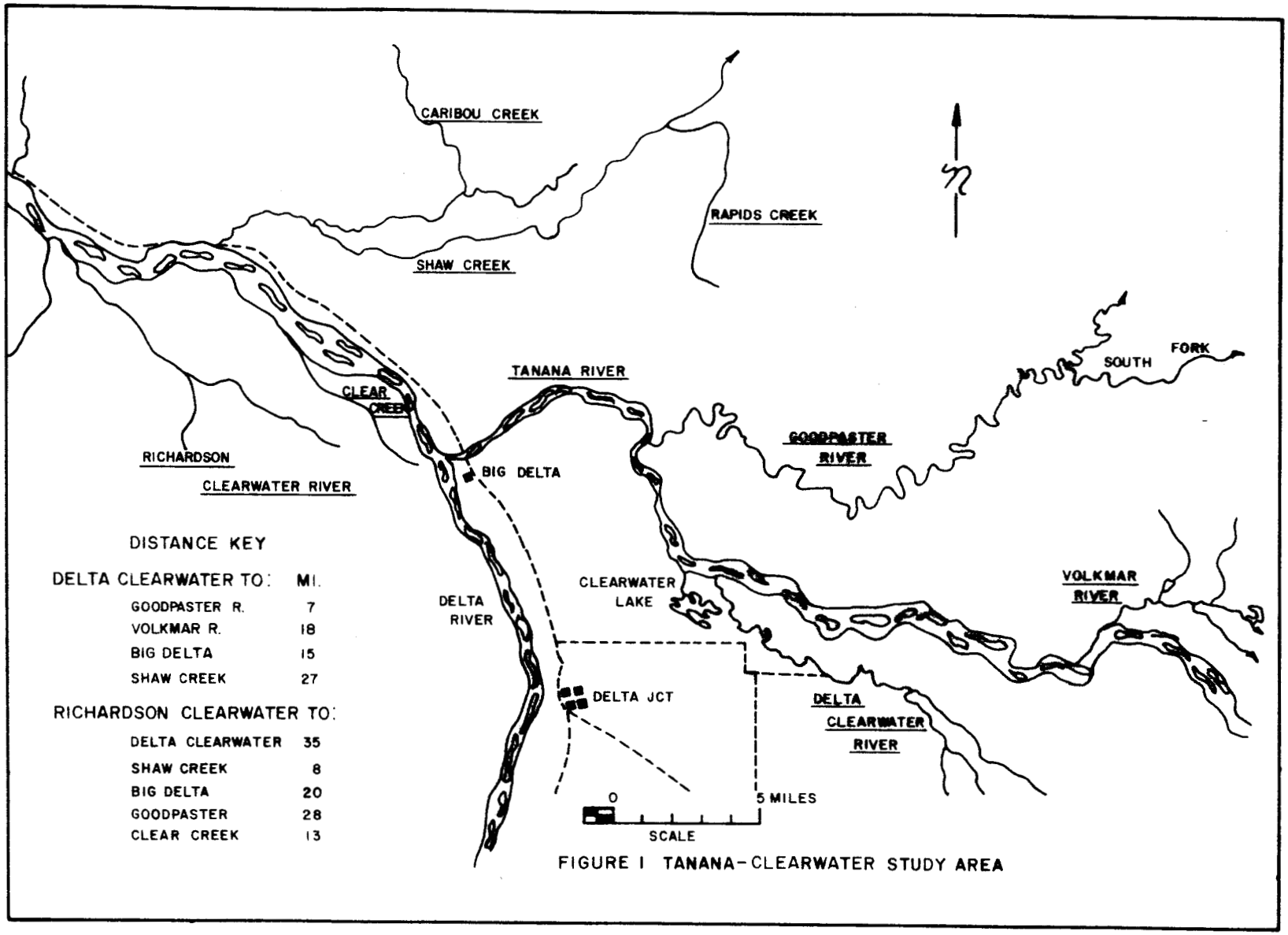

FIGURE 1 TANANA-CLEARWATER STUDY AREA

Fairly constant water flows and water temperatures characterize this and other interior Alaskan spring-fed systems. The river provides a very popular sport fishery for Arctic grayling and a growing fishery for the fall run of coho salmon. Public access is available at the State of Alaska Clearwater Campground at Mile 8 of the river and includes a boat launching ramp. Downstream access is also provided via Clearwater Lake where the U.S. Army has a launching facility. The two access points provide a popular float trip for canoists and kayakers.

Common and scientific names and abbreviations of fish referred to in this report are listed in Table 1.

TECHNIQUES

All lengths of fish species mentioned in this report were measured to fork length. All grayling tagging utilized Floy FD 67 anchor tags.

Fish population sampling to obtain estimates of relative abundance in the Delta Clearwater River was done by utilizing an alternating current boat-mounted shocker described by Van Hulle (1968). Grayling and whitefish were captured during a single downstream run. At the end of each 1-mile section, lengths and scale samples were taken and all grayling and whitefish were counted. Grayling were released within the section in which they were captured. Identical techniques were used in the Richardson Clearwater River sampling, with the exception that sections were delineated by a 20-minute shocking run rather than by distance.

Spring areas were sampled with either a Coffelt backpack dc shocker, a 1/4 in mesh Wyoming-style fyke net or a 6 ft x 25 ft straight seine with 1/4 in sq mesh. Additional surveys of spring areas were done visually. Grayling $\geq$ 200 mm captured in Delta Clearwater spring areas were tagged.

Sampling at Mile One Slough utilized a New Hampshire style fyke net with a 50 ft lead attached to one end to block the slough. All fish species captured were measured and a random sample of grayling had scale samples taken. All grayling $\geq$ 200 mm were tagged. Water temperatures were recorded to the nearest 1/2 degree Celsius as close to mid-day as possible. Delta Clearwater River temperatures were recorded above Mile One Slough.

Spring sampling in the lower Delta Clearwater River utilized the following fyke net styles: New Hampshire, South Dakota and Alaskan.

Sampling at Caribou Creek used a South Dakota style fyke net blocking the creek. Seine hauls were made to drive holding fish into the fyke net during the peak of the out-migration. All grayling captured during the downstream set were measured and those $\geq$ 200 mm were tagged. Scale samples were taken from the first fifty grayling $\geq$ 200 mm captured on three different days during the downstream set. Hook and line sampling above and below the mouth of the creek was done with spinning gear.

Table 1. List of common, scientific names, and abbreviations of fish species mentioned in this report.

Common Name	Scientific Name and Author	Abbreviation
Arctic grayling	Thymallus arcticus (Pallas)	GR
Burbot	Lota lota (Linnaeus)	BB
Chum salmon	Oncorhynchus keta (Walbaum)	CS
Coho salmon	Oncorhynchus kisutch (Walbaum)	SS
Humpback whitefish	Coregonus pidschian (Gmelin)	HWF
Least cisco	Coregonus sardinella Valenciennes	LCI
Longnose sucker	Catostomus catostomus Forster	LNS
Northern pike	Esox lucius Linnaeus	NP
Round whitefish	Prosopium cylindraceum (Pallas)	RWF
Slimy sculpin	Cottus cognatus Richardson	SSC

Recapture efforts in lower Shaw Creek utilized New Hampshire style fyke nets, the electrofishing boat, and a 6 ft x 100 ft bag seine of 3/8 in sq mesh. All grayling $\geq$ 200 mm were tagged.

Sampling in the Volkmar River used hook and line (fly fishing gear), an Alaskan style fyke net and a 6 ft x 100 ft bag seine of 3/8 in sq mesh. All grayling $\geq$ 200 mm were tagged and had scale samples taken.

All grayling scales used for age determination and scale variable analysis (circuli numbers and annuli distances) were taken from the fifth row above the lateral line and in line with the insertion of the dorsal fin. They were cleaned and those from fish less than 200 mm were mounted between glass slides and read using a Bausch and Lomb micro-projector at 46x magnification. For fish $\geq$ 200 mm, the cleaned scales were impressed on 20 mil acetate using a Carver press at 20,000 psi and heated to 200°F. They were aged along their dorsal radius using a 3M model 114 microfiche reader.

Determinations of stream and pond-reared grayling were made from counting circuli to and including the first annulus along the anterior dorsal fold. All circuli counts of eleven or greater were considered to be pond-reared fish as described by Peckham and Ridder (1979). Scale impressions selected for analysis of variables were projected by the microfiche reader and all circuli and annuli bisecting a line originating in the center of the focus and extending on a radius 10° anterior to the dorso-ventral axis were marked on a prepared form. Circuli that bisected the line but were less than 15 mm in magnified length were excluded. The completed forms were forwarded to the Alaska Department of Fish and Game Stock Separation Laboratory. The information was digitized and encoded as outlined by Krasnowski and Bethe (1978).

RECOMMENDATIONS

1. Index sampling of Arctic grayling and round whitefish in the Delta and Richardson Clearwater Rivers should be continued.

2. Monitoring of sport fish harvest in the Delta Clearwater River should continue.

3. The experimental program of pond rearing and transplanting of Arctic grayling to the Delta River should be continued, but utilizing grayling pond-reared for two summers versus one.

4. Assessment of the contribution of the enhancement program to year-classes and angler harvest should continue.

5. Monitoring of early spring fish movement in the Delta Clearwater should continue.

6. Investigations should be continued on the post-spawning migration of grayling from the Shaw Creek drainage, with emphasis on its Caribou Creek tributary, and from the Volkmar River to spring-fed systems.

7. A study on the dynamics and life history of the grayling population in Caribou Creek should be initiated.

8. Investigations on the post-spawning migration of grayling from the lower Goodpaster River to spring-fed systems should be initiated.

9. The evaluation of scale analysis as a tool in the separation of spring-fed systems grayling stocks should continue.

OBJECTIVES

1. To continue annual monitoring of existing stocks of Arctic grayling and whitefish in the Delta Clearwater River to determine changes in population structure, and to monitor existing stocks of Arctic grayling and whitefish in the Richardson Clearwater River to determine changes in population structure and similarity with trends in the Delta Clearwater River.

2. To assess transplanting of pond-reared grayling into the Delta Clearwater River to determine contribution to year-class strength and angler harvest, and to determine availability of local grayling egg sources for the pond-rearing program.

3. To evaluate the use of scale analysis in separation of spring-fed systems grayling stocks.

4. To investigate post spawning migration of adults from Shaw Creek to local spring-fed systems with emphasis on the Richardson Clearwater River.

FINDINGS

Monitoring of Arctic grayling and round whitefish stocks

Spring monitoring:

Since 1976 spring monitoring of Arctic grayling and round whitefish has taken place at Mile One Slough, a side channel of the Tanana River that enters the Delta Clearwater at Mile One. The slough is strongly influenced by springs during the months the Tanana is low and non-glacial. A fyke trap is fished totally blocking the slough at its mouth. A percentage of fish entering the Delta Clearwater from the Tanana in April move into the slough prior to further movement, possibly due to its temperature typically being several degrees warmer than the Delta Clearwater.

Fish, other than rearing coho salmon, were first observed when three whitefish were seen in the Delta Clearwater on April 7, 1980 at Mile 5. Approximately 12 whitefish were observed below the campground at Mile 8 and

another 100 at Mile 6 on April 11 when the fyke trap was set in Mile One Slough. Initial fish observations in past years have occurred as early as April 10 (Pearse, 1974) and as late as April 18 (Ridder, 1980) and indicates 1980 was an early year for fish in-migration to the Delta Clearwater. Smaller fish may well have entered the river prior to the initial fish sightings since visual surveys are biased toward larger individuals. In 1979, the only year of spring monitoring when the fyke trap was set prior to fish observations, the total catch of grayling and whitefish less than 200 mm in fork length was the largest recorded, 60% above the previous high in 1977 (Table 2).

The fyke trap was fished continually from April 11 to May 2 for a total of 21 trap days. Total trap days in previous years' monitoring, in which the trap was fished only during weekdays, ranged from 8 in 1976 and 1977 to 12 in 1978 and 1979. Despite the increase in effort, the catch of grayling and whitefish, 545 and 280 respectively, was the lowest since 1976 and resulted in the lowest catch per unit effort (CPUE; number of fish per trap day) in the 5 years of monitoring. The catches of other fish species, though similar to the numbers caught in previous years, were also the lowest in CPUE of all years.

A summary of all species captured at Mile One Slough and the CPUE for grayling and round whitefish from 1976 to 1980 is shown in Table 2.

Table 3 presents the percent composition, length range, and mean length of each species captured at Mile One Slough in 1980. The majority of the fish were juveniles.

From the data presented in Table 2, a marked change can be seen in the compositions of grayling and round whitefish greater and less than 200 mm in fork length beginning in 1979. For the 3 years from 1976 to 1978 grayling greater than 200 mm (Age III and older) composed from 40 to 53% of the total grayling catch and same size whitefish ranged from 90 to 98% of the total catch. In 1979 and 1980 these grayling dropped to a composition of 12% for both years, while whitefish fell to 53% in 1979 and to 36% in 1980. In 1979, it was suggested a late in-migration may have accounted for the length composition changes, since fish were not sighted in the river until April 18 (Ridder, 1980). Juvenile grayling are known to precede the older and larger grayling into the system.

In 1980, timing could not be a factor, since fish were first observed unusually early.

From an analysis of daily catch statistics a stratification in timing and size for the 1980 in-migration of grayling and whitefish is apparent. Of the 480 grayling less than 200 mm captured during spring monitoring, 46% (220) were caught over the 3 days from April 23 to April 25, while the catch from the first 11 trap days represented 34% of the total. The largest captures of whitefish less than 200 mm occurred over 2 days, April 28-29 when 52% (84) of the total 161 were caught. Of the fish greater than 200 mm, 77% (50) of the grayling and 81% (72) of the round whitefish were captured prior to April 23. In previous years (Peckham 1977, Peckham and Ridder 1979, and Ridder 1979 unpubl.), major catches of both species and size ranges coincided.

Table 2. Summary of fish captured by fyke trap and CPUE for grayling and round whitefish at Mile One Slough, 1976-1980.

		1976	1977	1978	1979	1980
GR:	<200	242	757	763	1,016	480
	≥200	159	436	869	140	65
RWF:	<200	8	52	43	279	161
	≥200	380	486	953	322	89
SS		318	681	692	1,744	612
HWF		6	3	60	74	68
SSC		6	8	2	5	1
BB		15	11	8	22	13
LCI		442	6	5	12	30
NP				1	1	1
LNS			2		3	15
# Trap Days		8	8	12	12	21
CPUE* GR		50	148	136	96	26
RWF		49	67	83	50	12

* Catch per day.

Table 3. Composition and length ranges of fish species captured at Mile One Slough, April 11-May 2, 1980.

Species	Number	Percent	Length (mm) Range	Mean
GR	545	36	70-300	176
RWF	250	16	68-408	172
HWF	68	4	130-337	259
LCI	30	2	128-344	194
LNS	15	1	70-162	90
SSC	1*	(<1)	88	88
NP	1	(<1)	560	560
BB	13	1	128-260	189
SS	612	40	70-110	87
	1,535			

* Gravid Female

In 1980, over the 4 days April 24-27, observations of large numbers of fish (> 500), the majority being large round whitefish, were made in the 2 mi of river below Mile One Slough and above Clearwater Lake Outlet. Since trapping at Mile One Slough failed to capture large fish during this period a fyke trap was set one-half mile below the slough and was fished for 3 days. Fifty-one round whitefish with an average length of 317 mm and 10 grayling averaging 209 mm were captured. The catch at Mile One Slough for the same time period totaled six whitefish averaging 86 mm and 12 grayling averaging 114 mm.

As seen by the changes in length composition and catch statistics, grayling and whitefish utilization of Mile One Slough in 1980 and 1979 was decidedly unlike that found in the first 3 years of monitoring. Temperature differences between the slough and river in 1980 ranged from a high of 2°C on April 18 and 24 to 0°C on May 2, which is similar to previous years.

Timing and composition of the run may have had an effect in the captures of 1979 but not in 1980. The only apparent difference between the past 2 years and the first 3 years was an island, 2 ft high and approximately 5 by 15 ft formed by the deposition of silt at the current interface of the slough and river, and located upstream of the slough's mouth. The island persisted through most of the 1979 trapping and all of the 1980 trapping. Though possibly mere coincidence, the current shift caused by the island could have affected the migration behavior to an extent that lessened the attraction that the slough had offered to the larger, older fish during previous years. If so, this behavior would seem to contradict the theory that temperature was the sole attractor of the slough, at least for older fish, during their upstream migration.

Although length compositions of grayling and round whitefish have changed since 1978, the percentage of each in their total combined catch has remained relatively constant. Grayling composed 69% of the combined catch in 1977 and 1980, 62% in 1978 and 66% in 1979.

Water temperature appears to influence the spring migration of grayling and whitefish into the Delta Clearwater River. The largest daily capture at Mile One Slough and the first observation of large numbers of fish in the river below the slough were on April 23, 12 days after setting the fyke trap. On this date the temperature of Delta Clearwater first reached 5°C. A review of 3 years of temperature data from previous spring monitorings (Ridder, unpubl.) obtained from a maximum-minimum thermometer failed to show any patterns until the recorded temperatures were averaged. When the average temperature in the river reached 5°C, daily captures of grayling and whitefish increased greatly and within 1 to 3 days reached their greatest numbers in all 3 years (Ridder, 1977-1978 field notes).

Grayling response to temperatures during pre-spawning migrations, onset of spawning, and fall movements to overwintering areas has been well documented (Tack 1980). In this spring in-migration, the grayling population is composed of nearly all juvenile and sub-adult fish migrating from overwintering areas to a non-parent stream strictly for feeding.

An attempt was made in 1980 to gauge the percentage of the grayling in-migration that was captured at Mile One Slough. All captured grayling greater than 200 mm were tagged with Floy FD 67 anchor tags and those less than 200 mm received a right ventral fin clip. Two fyke traps were fished 3/4 mi above Mile One Slough, one on each side of the river just outside the main channel. Trap success was poor, with only the north side set capturing grayling. Over an 11-day period they caught 34 grayling, 15 round whitefish and approximately 300 juvenile cohos. Three (8.8%) of the grayling captured were found marked with the right ventral clip. During the same time period, a fyke trap was fished at the mouth of Spring #3 at Mile 8 of the river and captured 31 grayling, of which one was found marked with a fin clip. A seine haul at Remington Spring, Mile 8.75, on April 24 captured 21 grayling, of which two were found marked; one with a fin clip and one tagged in the slough on April 18. A total of 86 grayling was thus caught upstream of the slough, six, or 7%, of which were found marked. Since the marking encompassed only the last 12 of the 21 days of fyke trapping, the upstream catches, especially those in the spring areas, could have included grayling that had in-migrated prior to the marking.

The adjusted age frequency of grayling captured at Mile One Slough in 1979 and 1980 is shown in Table 4. The method of adjustment for the 1979 data is described by Ridder (1980). For the 1980 data, scale samples from 112 grayling were collected during the first 2 days of fyke trapping, of which 14 or 12%, were found to be Age I. Since 200 of the 545 grayling captured at Mile One Slough fell below 119 mm, the upper length limit of Age I grayling, and represented 37% of the total sample, the age frequency and numbers of Age I fish in Table 4 were adjusted accordingly. The number in each older age group in Table 4 is derived from the sample of 112.

The age frequencies of grayling captured at Mile One Slough are remarkably similar in both 1979 and 1980 with the obvious exception of Age Class I. The decline in the frequency of Age I, from 50% in 1979 to 37% in 1980, is considered almost entirely due to the lack of pond-reared grayling in the 1979 year class. In 1979, no stocking of Age 0 grayling was conducted under the enhancement program. If the contribution of the enhancement program to Age I in 1979, 41% (Ridder 1980), is subtracted from the total number of 1979 Age I fish in Table 4 and the frequencies recomputed, the resulting frequency of Age I would be 37%, of Age II 41% and of the older age groups, 1-2 percentage points higher. All would be similar to the frequencies found in 1980.

Index Sampling:

Delta Clearwater River. Index sampling for Arctic grayling and round whitefish was conducted in the Delta Clearwater River from Mile 17 to the mouth on July 15 and 16, 1980 and the total capture for grayling (182) surpassed the high catch of 1979 (157), by 16%. The average capture for the 5 years from 1973 to 1978 was 86 grayling. The river is divided into three sections described by Ridder (1980) and the relative capture rates for each of them is presented in Table 5 along with like data from 6 previous years.

Table 4. Adjusted Age Frequency of Arctic grayling captured at Mile One Slough, April, 1979 and 1980.

Age Class	1979			1980		
	n	%	Mean Length (mm)	n	%	Mean Length (mm)
I	578	50	98	58	37	95
II	379	33	159	53	34	161
III	109	10	202	30	19	208
IV	57	5	238	13	8	238
V	28	2	...	2	2	269
VI	1	(<1)	...	...	...	...
	1,152			156		

Table 5. Capture rates per section for Arctic grayling and round whitefish during index sampling, Delta Clearwater River, 1973-1980.

Species	Date	Mile Sections 0-7	8-13	14-17	Total Captured	Percent Composition
GR	6/27/73	9	20	66	95	15.7
	7/02/75	13	8	43	64	14.0
	6/30/76	17	27	41	85	17.3
	7/06/77	27	25	49	101	22.2
	7/10/78	50	28	9	87	16.7
	7/17/79	59	24	74	157	23.3
	7/15/80	39	45	98	182	38.5
RWF	6/27/73	189	159	163	511	84.3
	7/02/75	37	117	239	393	86.0
	6/30/76	116	163	128	407	82.7
	7/06/77	96	107	151	354	77.8
	7/10/78	142	237	54	433	83.3
	7/17/79	150	174	194	518	76.7
	7/15/80	82	118	91	291	61.5

In the upper section, Miles 14 to 17, the capture rate for grayling has dramatically increased from a low of nine grayling in 1978 to 74 in 1979 and to 98 in 1980. This section is populated predominantly by adult fish, Age V and older.

The middle section, Miles 8 to 13, which has had the most consistent capture rate since 1973, averaging 22 grayling, produced an increase of 100% in 1980 to a capture rate of 45. This section is composed of both adult and subadult grayling of Ages IV and older.

The lower section, Miles 0 to 7, is made up of predominantly juvenile and subadult fish Ages I to IV. This section had a catch rate of 39, a decrease from the high of 59 recorded in 1979. The capture rate for this section had been steadily increasing since 1973 and was attributed to the recruitment of pond-reared grayling from the enhancement program to the older age classes that are more susceptible to electro-fishing (Ridder 1980). Several possible reasons for this decline are: a combination of older pond-reared fish moving into the upper sections of the river, the lack of enhancement in 1979 (Age I in 1980), the difficult shocking of the section due to high winds in 1980, and poor recruitment of "wild" grayling.

The total capture of round whitefish in 1980 was the lowest since the index sampling was established. Since effort during the index runs has been directed to the capture of grayling, the rates shown in Table 5 should be viewed accordingly. The total whitefish captured is as dependent on the number of grayling in the system as on their own numbers. Still, the low rate in 1980 (291) does suggest fewer fish in the river than in past years. In 1979, the largest number of whitefish (518) in any index sampling was captured concurrently with the largest number of grayling captured to that time.

The age frequency and length of 166 Arctic grayling captured during the 1980 index run are presented in Table 6 and a comparison of age compositions from all years of index sampling is shown in Table 7.

Age Class V, the 1975 year-class, was predominant in the 1980 sample at 27% of the total. There were only a few percentage points separating it from Age Classes IV (26%) and VI (25%), year-classes 1976 and 1974 respectively. This similarity was not expected, considering the year-classes' composition found in 1979 where the 1975 class was weak (Table 7). The 1974 year-class produced predominant age classes in both 1978 and 1979 and was expected to do so again in 1980. These three year-classes have shown strong recruitment to all their age classes from 1977 to 1979 with the unexplained exception of the 1975 year-class in 1979. In past reports (Peckham and Ridder 1979; Ridder 1980), these strong year-classes were shown to be due in part to the enhancement program that was initiated in 1974 and which will be discussed later in this report.

The compositions of Age Classes I, II and III are lower than in past years (Table 7). For these younger fish, it is felt that the smaller numbers of fingerlings stocked in the enhancement program during the previous three years contributed to the decline. In 1978, the cumulative composition of

Table 6. Age frequency and length of Arctic grayling captured with electrofishing gear in the Delta Clearwater River, July 15, 16, 1980.

Age Class	Number	Percent	Length (mm) Range	Mean
I	0	0	...	...
II	10	6	175-220	196
III	16	10	201-263	238
IV	43	26	219-314	265
V	45	27	241-366	308
VI	41	25	295-359	332
VII	5	3	337-391	368
VIII	2	1	366-372	369
IX	4	2	394-414	402
Totals	166	100	175-414	294

Table 7. Percent age composition of Arctic grayling electrofished in the Delta Clearwater River, 1975-1980.

Age Class	1975	1976	1977	1978	1979	1980
I	0	0	0	2	2	0
II	0	1	6	16	9	6
III	0	6	15	20	15	10
IV	11	13	20	24	10	26
V	33	28	13	18	32	27
VI	33	42	27	6	12	25
VII	14	9	16	14	11	3
VIII	5	1	1	0	8	1
IX	4	0	1	0	1	2
X	0	0	1	0	0	0
	n=63	n=76	n=98	n=80	n=152	n=166
mean length (mm)	...	...	277	252	285	294

Age Classes I to III was 38%, in 1979 it was 26% and in 1980, 16%. The 1980 compositions though, are still higher than those in 1975 or 1976.

Age Class VII, the 1973 year-class and 3% of the sample in 1980, was also much lower than in past years where this age class average composition was 13%. As seen in Table 7, this year-class was also poorly represented in the two previous index runs as Age Classes V and VI, yet gave a strong composition as Age Class IV in 1977.

The mean fork lengths of each age class shown in Table 6 are comparable to previous years, while the mean fork length of the total sample, 294 mm, was greater than the 285 mm mean found in 1979, the 252 mm found in 1978 and the 277 mm in 1977.

Richardson Clearwater River

Sampling with the electrofishing boat was conducted on the Richardson Clearwater River on July 17, 1980 to monitor population structure for comparisons to the Delta Clearwater River. Unlike the Delta Clearwater sampling, the numbers of grayling and round whitefish captured, 170 and 33 respectively, cannot be compared at face value to the captures of the previous 4 years (see Table 8) in estimating relative abundance. Time of sampling and length of river sampled have been inconsistent over the 5 years. In 1979, sampling dates were moved from the late August dates of 1977 and 1978 to coincide with the Delta Clearwater's index sampling in July. At this time, grayling and whitefish are dispersed throughout the river, unlike the August situation when they are dropping out of the upper sections and concentrating in the lower rivers (Pearse, 1974, Tack 1974, 1979). The 1979 capture of 64 grayling was the lowest catch of all sampling years despite the abundance of grayling observed (Ridder 1979). The morphology of the river at the start of the shocking run precluded effective capture and in effect distorted any estimate of relative abundance. In 1980, an additional 1.3 mi of river starting from the first major tributary at Mile 7 to a second tributary upstream was included. River width and water depth precluded more mileage. Ninety-seven grayling and no whitefish were captured in this new section which is characterized by long narrow runs divided by braided, and very shallow riffles. (The abundance of grayling observed surprised the sampling crew and resembled a raceway full of brood stock). Subtracting these 97 fish from the total gives a capture of 73 grayling and 33 whitefish in the lower 7 miles, which can then be compared to the 1979 figures of 63 grayling and 105 whitefish found in this section. As in the Delta Clearwater, index sample, the relative capture rate of grayling increased and that of round whitefish decreased. A summary of the 1980 index run, as well as those of previous years, is shown in Table 8.

The age frequency and lengths of 152 grayling from the 1980 Richardson Clearwater sampling are presented in Table 9, and a comparison of age frequencies from the 5 years of sampling is shown in Table 10. As it has been since 1978, the 1974 year class represented by Age Class VI was predominant with 33% of the sample. Similar to the closeness of compositions of Ages V and VI in the Delta Clearwater River, where Age V were

Table 8. Captures of Arctic grayling and Round whitefish electrofished in the Richardson Clearwater River, 1973 to 1980.

Date	No. grayling	No. Round whitefish	River Miles Sampled
8/01/73	75	...	4
8/30/77	104	123	7
8/31/78	117	53	7
7/17/79	63	105	7
7/17/80	170 (73)*	33 (33)	8.3 (7)

* Numbers in parenthesis indicate captures in lower 7 mi.

Table 9. Age frequency and length of Arctic grayling captured in the Richardson Clearwater River, July 17, 1980.

Age Class	Number	Percent	Length (mm)	
			Range	Mean
I	0			
II	4	3	133-185	160
III	3	2	217-235	225
IV	25	16	229-286	251
V	49	32	265-330	298
VI	50	33	252-387	322
VII	16	11	325-393	352
VIII	5	3	367-402	380
	152		133-402	301

Table 10. Percent age Composition of Arctic grayling electrofished in the Richardson Clearwater River in 1973, and 1977 through 1980.

Age Class	Aug. 1973*	Aug. 1977	Aug. 1978	July 1979	July 1980
I	4	0	1	0	0
II	0	2	3	2	3
III	17	15	17	11	2
IV	29	10	46	26	16
V	35	21	15	39	32
VI	11	33	11	11	33
VII	3	15	7	6	11
VIII	0	4	0	5	3
IV	0	0	0	0	0
X	1	0	0	0	0
	n=75	n=100	n=74	n=62	n=152
Mean length (mm)	___	291	252	280	301

* Only lower 4 mi were sampled. In 1977-1979 the lower 7 mi were sampled and in 1980, the lower 8.3 mi.

predominant, only 1 percentage point separates Age VI from Age V. Unlike the Delta's sample, where Age Class IV's composition was also similar to those of Ages V and VI, Age IV represented only 16% of the Richardson's sample and was below the 28% average composition of the 4 previous years. The difference is felt to be partly attributable to the grayling enhancement program in the Delta Clearwater. Twenty-three percent of Age IV fish in the Delta sample exhibited the high circuli counts to the first annulus, typical of the enhancement grayling; whereas only 4% of the Age IV fish in the Richardson sample possessed them. Likewise, the low compositions of Age Classes II and III in the Richardson, 3% and 2% respectively, compared to the 6% Age II and 10% Age III fish found in the Delta sample are due to the influence of the pond-reared grayling of the enhancement program. Sixty-five percent of these age groups in the Delta Clearwater sample exhibited high circuli counts, whereas they were nonexistent in the Richardson sample. The composition of Age Class III, (2%) found this year in the Richardson, like Age Class IV, is considerably below the average composition of 15% found in the 4 previous years.

The mean lengths of each age group in the Richardson sample (Table 9), are less than those found in the Delta sample (Table 6) with the exception of Age Class VIII. Excluding this age group because of the small sample size, the differences range from 36 mm found in Age Class II to 8 mm in Age Class IV and average 15.5 mm for the six age groups combined. While part of the difference is undoubtably due to the greater average size of pond-reared grayling used in the Delta's enhancement program studies, past studies, especially Pearse's (1974) length comparisons, also pointed out the differences in average lengths of Delta and Richardson Clearwater grayling. While the productivity of each of these spring systems may be different, it is considered of minimal importance in describing these growth differences. Tagging experiments described later in this report indicate this discrepancy in length is possibly due to differences in the primary nursery streams from which the respective spring-fed system grayling populations are recruited.

While mean fork lengths of age groups differed, the mean length of the total sample was 301 mm in the Richardson with a range from 133-402 versus 294 mm in the Delta and with a range from 175 to 414. As in the Delta sample, this mean length was an increase from the 285 mm found in 1979, 252 in 1978 and 277 mm found in 1977, and indicates the greater numbers of large grayling in the spring systems in 1980.

Clear Creek:

Clear Creek, a small spring-fed system lying on the south side of the Tanana River, was surveyed on July 7, 1980. It flows from its source near Big Delta (9 mi northwest of Delta Junction) 7 mi into a side slough of the Tanana River approximately 4 mi above Shaw Creek. With the exception of its extreme upper end, the creek's width averages between 15 and 18 ft along most of its length.

Unlike the Delta and Richardson Clearwater Rivers, spring areas are prevalent only in the upper third of the creek, diminish in numbers quickly

along its mid-section and are quite infrequent along its lower end. The entire upper 2 mi could be considered one large spring area. This results in a temperature gradiant which ranged from 4.0°C in the upper mile to 5.5°C at roughly its mid-point and to 7.0°C near its mouth.

Fish distribution appeared to be affected by the temperature gradient, in that no fish were captured or observed until approximately the Creek's mid-point although suitable habitat was available. Here, small, isolated schools of grayling were observed and sampled. Size and frequency of grayling schools increased somewhat downstream but were never abundant. No other fish species as noted. In August, 1979, grayling and round whitefish were sampled and observed only in the lower 1/2 mi of the creek (Ridder, 1979), though in 1980 no fish were observed in this section.

The age frequency and lengths of 52 of 58 Arctic grayling sampled in Clear Creek in 1980 are presented in Table 11. Their fork lengths ranged from 179 to 330 mm with a mean of 256 mm. In 1979, the range was from 194 to 356 mm with a mean of 250 mm. The predominant age group was Age Class IV with 58% of the total, followed by Age Class V with 19% and Age Class III with 17%. In 1979, out of a sample size of 39, the predominant age group was Age Class III with 43%, followed by Age Class IV with 26% and Age Class V with 23%. In 1978 the predominant was Age Class IV.

Although outward appearance may categorize Clear Creek as a minature version of the larger spring systems such as the Delta and Richardson Clearwaters, fish utilization appears decidedly different. Round whitefish and rearing coho salmon were absent during the 1980 survey of Clear Creek, yet are abundant in the larger systems. Grayling utilization of the creek is predominantly immature or subadult fish, whereas the reverse is true of the Delta and Richardson systems. Also, the few larger grayling observed or captured in Clear Creek were in the lower reaches, which is again the reverse of the large systems.

Angler Harvest:

Creel census was conducted on the Delta Clearwater River from May 9 to September 1, 1980 using a stratified random schedule. A total of 189 as contacted, of which 59 represented completed trips. Boat anglers represented 61% of the completed trips (58% in 1979 and 59% in 1978) and had a catch rate of 0.70 grayling per hour, an increase over the 0.68 rate in 1979 and the 0.51 rate in 1978. Shore anglers comprised the rest of the completed trips and had a catch rate of 0.59 grayling/hr, a significant increase over the 0.30 and 0.34 rates found in 1979 and 1978, respectively. The combined catch rate was 0.70 fish per hour for completed trips, an increase over the 0.60 fish per hour calculated in 1979 and the 0.54 fish per hour in 1978. A summary of the creel census by month is shown in Table 12 and includes both complete and incomplete trips.

Including both complete and incomplete trips, the 0.75 fish per hour recorded in 1980 is the highest recorded and represents only those fish taken. Including released fish, the catch rate was 0.81 fish per hour. Much of the increase can be attributed to the grayling enhancement program

Table 11. Age frequency and length of Arctic grayling captured by hook and line in Clear Creek, July 7, 1980.

Age Class	Number	Percent	Length (mm)	
			Range	Mean
II	2	4	179-204	192
III	9	17	213-247	230
IV	30	58	217-283	253
V	10	19	253-323	291
VI	1	2	330	330
	52		179-330	256

Table 12. Creel census summary, boat and shore anglers combined, Delta Clearwater River, May 9 through Sept. 1, 1980.

Month	Anglers Contracted	Angler Hours	Grayling Caught	Mean Length (mm)	Fish Per Angler	Hours Per Angler	Fish Per Hour
May	39	78.5	51	...	1.3	2.0	.65
June	35	50.25	48	...	1.4	1.4	1.00
July	64	108.0	71	...	1.1	1.7	.65
August	51	64.5	52	...	1.0	1.3	.77
Totals	189(59)*	301.25	222	277	1.2(1.6)	1.6(2.3)	.75(.70)

* Numbers in parenthesis are for completed trips only.

begun in 1975 and which in 1980 contributed to four of the seven year classes present in the creels. As will be discussed later in this report, the program was responsible for 21-31% of the harvest. Subtracting the higher percentage from this year's censused catch would give a catch rate of 0.51 fish per hour, which compares to the average catch rate of 0.45 for the eight censused years from 1953 to 1976. A comparison of 12 years of censused catch data, from 1953 to 1980, is shown in Table 13.

Table 14 gives a comparison of estimates on man-days of effort and grayling harvest for the Delta Clearwater River for 1977-1979 derived from creel census programs and from results of a statewide harvest survey (Mills, 1979, 1980, and 1981). Though the state-wide survey has estimated higher angler pressure than the on-site census program for the 3 years, the harvest estimates from both programs are remarkably close. Because of this, the 1980 creel census effort was directed towards catch success and composition rather than harvest and pressure estimates.

An estimate derived from the 1980 creel census data is not considered as reliable as previous estimates, since censusing in 1980 was 64% less than in 1979 and 1978 and accounted for only 20% of the 116 day season. Technique was also different, as it was directed toward angler contact. In previous years effort was split equally between censusing and angler counts. Though considered low, the estimate of 5,878 grayling harvested, 16% below the 1979 harvest, and 3,586 man-days of effort (8,248 angler hours), which is 33% below the 1979 estimate, does parallel general observations of a decrease in effort in 1980.

The age frequency and length of 147 grayling harvested by anglers in 1980 are presented in Table 15 and are compared in Table 16 with the age compositions found during index and creel sampling, for the years 1977-1979. As in the 1979 sample, the creel sample favors younger fish in comparison with the index sampling. Age Class IV is decidedly predominant in the 1980 creel sample with 41% of the total, while index sampling showed Age Class V with 27% and Age Class IV with 26%. The younger fish of Age Classes I-IV made up a larger percentage in the 1980 creels, (59%) than in previous years (38% in 1979, 1978, and 1977) and compare to the 42% found in the 1980 index sampling. Of the older fish, Age Classes VI-IX, the creel sample contained 17% while the index sample had 32%, as was the case in 1979. These differences in age compositions between the two samples, particularly of the older age classes, are a function of location. The majority of anglers, whether they use a boat or go on foot, fish within 3 mi of the main access points at Mile 8 of the river. As previous studies have shown, (Pearse, 1974; Tack, 1980;) the majority of the larger, older grayling utilize the river above Mile 12 and thus are out of the average angler's reach.

The mean fork length of 147 harvested grayling was 277 mm, up slightly from the mean of 273 mm found in 1979. The index sampling showed a mean of 294 mm in 1980, which was also an increase.

The length frequency of the 1980 creel sample is compared to five previous years in Table 17. The predominant length range of 265-314 mm found in

Table 13. Comparison of censused catch from the Delta Clearwater River, 1953-1979.

Year	Anglers Contacted	Angler Hours	Catch	Catch/Hour
1953	300	1,057	307	0.29
1954	48	113	52	0.46
1955*	52	172	126	0.73
1956*	172	680	211	0.31
1957*	102	514	211	0.41
1958*	115	835	259	0.31
1973	315	664	436	0.65
1976	58	124	52	0.42
1977	307	596	333	0.56
1978	453 (274)**	1,049 (723)	592 (385)	0.56 (0.54)
1979	390 (191)	840 (469)	504 (286)	0.59 (0.60)
1980	189 (59)	301 (136)	222 (92)	0.75 (0.70)

* 12-inch size limit in effect from 1955-1958.
** Numbers in parenthesis are for completed trips only.

Table 14. Comparison of statewide harvest survey and Delta Clearwater Creel census estimate 1977-1979.

Year	Harvest Survey		Creel Census	
	Mandays	Harvest	Mandays	Harvest
1977	6,881	6,118	5,923	6,397
1978	7,210	7,657	6,206	7,638
1979	8,398	6,492	5,379	6,968
1980	...	...	3,586	5,878

Table 15. Age frequency and length of sport harvested Arctic grayling, Delta Clearwater River, May 9 - Sept. 1, 1980.

Age Class	Number	Percent	Length (mm) Range	Length (mm) Mean	Index
II	7	5	195-258	219	196
III	19	13	207-282	248	238
IV	61	41	216-326	266	259
V	35	24	260-335	293	308
VI	18	12	260-339	309	332
VII	4	3	332-343	338	368
VIII	3	2	356-372	366	369
	147			277	294

Table 16. Comparison of age composition (%) between creel (hook and line) and index sampling (electrofishing gear), Delta Clearwater River, 1977-1980.

Age Class	1977		1978		1979		1980	
	Creel	Index	Creel	Index	Creel	Index	Creel	Index
I	0	0	0	2	0	2	0	0
II	3	6	2	16	2	9	5	6
III	11	15	8	20	17	15	13	10
IV	24	20	28	24	19	10	41	26
V	33	13	19	18	45	32	24	27
VI	19	27	14	6	11	12	12	25
VII	9	16	22	14	6	11	3	3
VIII	1	1	7	0	(<1)	8	2	1
IX	0	1	0	0	0	1	0	2
X	0	1	0	0	0	0	0	0
n=	139	98	97	80	225	152	147	166

Table 17. Length frequency of sport harvested Arctic grayling, Delta Clearwater River, 1973-1980.

Length Class (mm)	1973 %	1976 %	1977 %	1978 %	1979 %	1980 %
115-164	0	0	0	0	0	0
165-214	3	0	10	3	3	3
215-264	19	9	19	18	36	34
265-314	39	52	46	37	46	47
315-364	24	36	21	29	14	14
365-414	13	3	4	11	1	2
415-464	2	0	0	3	0	0
Mean Length (mm)	304	305	284	299	273	277
Mean (in)	11.9	12	11.2	11.7	10.7	10.9
Number in sample	120	33	142	202	227	147

1980 is unchanged from the previous 5 years. A large increase in the 215-264 mm length range, first noted in 1979, continued in 1980. From an average of 16% in the years 1973 to 1978, this range jumped to 36% in 1979 and 34% in 1980, and is indicative of the positive effects of the enhancement program on recruitment. This recruitment should turn around the decline of the larger length ranges, 315-464 mm, that represented 39% of the 1973 sample, 25% in 1977, and 16% this year. Discounting the 1976 figures due to small sample size and also the 1978 sample because of possible bias (Peckham and Ridder, 1979), 1980 was the first year that did not register a decline in these length ranges and, in fact, showed a slight increase over the 15% found in 1979.

A voluntary creel census program was conducted on the Richardson Clearwater River in 1980, not only for catch statistics, but as an aid in monitoring recaptures of fish tagged in the Shaw Creek drainage. An introductory letter explaining the creel census and tagging program, together with tally sheets and a stamped return envelope, were distributed to stream residents on June 8 either in person or tacked in a prominent location by the front door. The Richardson is not well known and thus is fished predominantly by its summer residents who are quite protective and jealous of the river's charms; the fishery not the least of them. Eighteen packets were distributed to them and to date, eight or 44% have been returned. The response was expected to be higher but as one apologetic respondent remarked, "They were afraid of being pinched".

The eight respondents included one who didn't fish and one who didn't record his catches but returned four tags. The six who recorded catch information represented 47 angling trips and 144 man-days of effort that translated into 284 angler hours. Total grayling caught were 904, of which 418 were kept. The catch rate of 1.47 grayling per hour (4.28 grayling per hour including released fish) was similar to the 1.29 rate recorded in a voluntary program on the Delta Clearwater River in 1978 (Peckham and Ridder, 1979). Extrapolating this data in a simple ratio to include non-respondents would give minimum harvest and pressure figures of 995 grayling harvested with 334 man-days of effort during the 1980 season.

A total of 40 tags was returned by the respondents, including 28 tags from the 418 grayling creeled. Two respondents apologized for not including all of their tags, some of which were left on their cabin windowsills.

Grayling Stock Enhancement

Spring Surveys;

The grayling enhancement program was begun in 1974 with the stocking of 250,000 fry into the Delta Clearwater River and Clearwater Lake. Plants continued yearly until 1979 and, with the exception of plants totaling 6,041 fingerlings and catchables made in the main river, all have been made in spring tributaries of the Delta Clearwater River. These included a single plant of 100,000 fry in 1975, 371 catchables in 1977, and four yearly fingerling plants totaling 29,048 from 1975 to 1978. Surveys of these six spring areas conducted in the spring following stocking have

observed and captured pond-reared fish and fingerlings of the program as early as April 5 in two of the areas and as late as May 2 in three. All areas except one held grayling by the first of May in every survey year. Although the early sightings (made before the spring in-migration of grayling and whitefish) suggest that overwintering occurs, it has never been documented in mid-winter. Numbers observed have also been quite small in relation to those stocked. Extensive surveys of both stocked and unstocked springs made between April and November of 1979 have noted that immature grayling of Age Classes I-III, both pond and stream-reared, have a preference for the temperature regimes of these areas during their spring and fall migrations. The majority of grayling stocked are considered to eventually migrate out of the system to overwinter in the Tanana River. They have been captured routinely with their stream-reared cohorts at Mile One Slough during the spring in-migration.

In 1980, surveys for juvenile grayling were conducted in four spring areas downstream of the Delta Clearwater system prior to observations of in-migrants in the Delta Clearwater River. Two areas, Bluff Cabin Slough, a spring-influenced slough to the Tanana River located 4.5 mi below the Delta Clearwater, and Bluff Cabin Spring, a spring tributary to the slough, were surveyed on April 1, and for the slough, again on April 14. In the spring area, seven species of immature fish were either observed or captured by backpack shocker. Ten captures of grayling were made. They were all of Age Class I and had a length range of 86-112 mm with a mean of 100 mm and all were stream-reared or wild fish, since no fingerling plants were made in 1979. No older grayling were observed. No fish were observed during the two surveys of the slough.

The third spring area, a slough of the Tanana River during high water, is located just below the outlet of Clearwater Lake and 0.5 mi below the mouth of the Delta Clearwater River. Two fish, approximately 100 mm long and species unknown were observed during an April 7 survey.

The fourth area is Clearwater Lake #2, a small secondary outlet of Clearwater Lake and heavily influenced by springs along its upstream half. In a survey of its lower end on April 7 rearing coho salmon were observed, but no grayling. An additional survey of the area on May 7 collected 18 gray§ing by seine; two Age I's with a mean length of 104, 15 Age IIs with a mean of 150 mm, and one Age III 197 mm in length. Only one Age II grayling had the high circuli count indicative of pond-reared grayling (Ridder 1980). A summary of the catch is included in Table 18.

Spring #3, located in Mile 8 of the Delta Clearwater River, has been utilized as a stocking site for each of the four grayling plants. A survey of the spring on April 8 observed five grayling of possible Age Classes II and III in its uppermost spring head and one grayling at the mouth.

The temperature on this date was 5.6°C in the spring and 3.0°C in the main river. A fyke trap was set on April 10 partially blocking the lower of the spring's two mouths, and fished continuously till May 2. Forty-nine grayling were captured over the 22 days of fyke trapping and included three tagged grayling that were stocked into the river above the spring in

Table 18. Mean length in mm and percent composition of Arctic grayling with circuli counts to and including the first annulus of 11 or greater and 10 or less, Spring areas, Delta Clearwater River, Spring, 1980.

Age Class	No. Circuli	Spring #3			Remington Spring			Clearwater Lake #2*		
		n	%	Mean Length	n	%	Mean Length	n	%	Mean Length
I	≤ 10	4	100	95	3	100	94	2	100	104
	≥ 11	0	0		0	0		0		
	Total	4	10	95	3	15	94	2	11	104
II	≤ 10	9	30	137	1	8	137	14	93	150
	≥ 11	21	70	190	11	92	190	1	7	150
	Total	30	71	169	12	60	185	15	83	150
III	≤ 10	6	75	202	3	75	199	1	100	197
	≥ 11	2	25	226	1	25	213	0		
	Total	8	19	205	4	20	203	1	6	197
IV	≤ 10	0			1	100	250			
	≥ 11	0			0					
	Total				1	5	250	0		
	Total	42			20			18		
	≥ 11	23	55		12	60		1	6	

* Located 1 mi below Delta Clearwater River and sampled on May 7.

September 1979 at Age I. Grayling of this plant were observed in the spring in October of 1979.

Thirty-three of the grayling were captured in one 24 hour period ending on April 25 and included one fish previously fin-clipped at Mile One Slough. The first large catch of grayling at Mile One Slough, 7 mi below the spring, occurred two days previously on April 23.

Age determinations from a sample of 42 of the grayling from Spring #3 showed 10% were Age Class I, 71% were Age Class II and 19% were Age Class III. In surveys of stocked springs made in previous years, Age Class I predominated in samples from all areas. In 1979, for example, 96% of a sample of 129 grayling collected from four areas were Age Class I and of these 88% were considered pond-reared fish. (Ridder, 1980) Since no plants were made in 1979, the pond-reared grayling would not have contributed to 1980's Age Class I. Pond-reared grayling comprised 55% of the 1980 sample from Spring #3 and included both Age Classes II and III.

In past years, no stream-reared fish have been captured in Spring #3. In 1980, 45% of the grayling captured in this spring area were stream-reared fish. Captures of these "wild" grayling had increased, though, in other spring areas during past years. In 1978, they comprised 6.6% of the total spring area sample, with 33% being captured in Spring #2 (1 mi below Spring #3) and 67% in Spring #1 (3 mi below Spring #3). In 1979, these wild grayling comprised 11.6% of the entire sample, with 92% 2% being captured in Spring #2 and 8% in Spring #1 (Ridder, 1980). No wild grayling were captured in spring areas in 1976 and 1977. In 1973, during preenhancement surveys of spring areas, Pearse (1974) captured grayling only in Spring #1. The strong schooling tendency in these immature grayling that results in stream-reared fish accompanying the pond-reared fish to their stocking areas indicates a common overwintering area. Conversely, this behavior could account for some of the loss to the system of the enhancement fish and thus contributions to other populations. A summary of Spring #3's sample is included in Table 18.

Remington Spring, located approximately 0.5 mi above Spring #3 and never utilized in the enhancement program, was surveyed on April 23, 1980 and some 30 grayling (5 with tags) were observed in its left fork. A seine haul made on April 24 captured 21 grayling, of which four were marked. Two marked fish were tagged and were from the grayling plant made downstream in 1979 (fish of this plant were observed in the spring in October of 1979) and two were marked earlier at Mile One Slough (one was fin clipped, one was tagged on April 18, 1980). Fifteen percent of a sample of 20 comprised Age Class I, 60% were Age Class II, 20% were Age Class III, and 5% were Age Class IV. These percentages are similar to those found in a sample of 34 grayling collected on May 30, 1979 where 24% were Age Class I, 59% Age Class II, and 17% Age Class III (Ridder 1980). In 1980, pond-reared fish were included in Age Classes II and III and comprised 60% of the total sample. In 1979, these pond-reared fish were found in all three age classes and comprised 47% of the total sample. A summary of the captures is included in Table 18.

Table 19 presents the mean lengths and percent composition of Arctic grayling of both stream origin (fewer than 10 circuli) and pond origin (more than 11 circuli) captured in three spring areas of the Delta Clearwater system. The percent compositions of the age classes are similar in all samples, with Age Class II being predominant. With the exception of the one Age IV fish captured in Remington Spring, all grayling captured during six years of spring area surveys have been Age III or younger.

The composition of pond-reared fish is highest in the upstream springs, Spring #3 and Remington Spring, and quite low in Clearwater Lake #2 and indicates the tendecy of these grayling to return to the general area (within three mi) in which they were stocked two and three years previously. The percentage of pond-reared fish in each age class found in the two upstream areas are similar; 70% of the Age IIs and 25% of the Age IIIs in Spring #3 were pond-reared and 92% of Age IIs and 25% Age IIIs were pond-reared in Remington Spring. This compares to the approximately 50% composition of pond-reared grayling in the same two age classes sampled at Mile One Slough during the same time interval.

Assessment of Year Class Contribution:

To assess the contribution of the enhancement program to the 1980 population of Arctic grayling in the Delta Clearwater River, scale samples were collected from spring monitoring at Mile One Slough, from index sampling in July and from angler creels throughout the season. The assessment is limited to those plants of pond-reared grayling which represent four year classes, 1975 through 1978 (Age Classes II thru V in 1980). These plants are easily defined by their circuli counts to and including the first annulus, which are typically greater than in stream-reared fish. (Pearse, 1976; Peckham 1977, and Ridder 1980). The contribution of the fry plants of 1974 (250,000) and 1975 (100,000) are not so easily defined since the circuli distinction is lacking. A summary of the numbers and percentages of pond-reared grayling from the enhancement program derived from the above three samples is presented in Table 19.

The composition of pond-reared grayling found during spring monitoring in 1980, 31%, is identical to that found in 1979 monitoring. Considering that this monitoring is predominantly of immature fish Ages I to III and that the pond-reared fish are represented in 1980 in Ages II to IV, which is essentially one less year class than in 1979, the similar percentages are unexpected. The pond-reared compositions found in the 1976 and 1977 year-classes (Ages IV and III) in 1980, 38% and 47% respectively, are considerably higher than the 25% found for each of them in 1979, and undoubtably affected the compostion of the total 1980 sample. Variable recruitment of wild fish to these year classes, timing and composition of the in-migration, or the different technique used in 1979 in computing contribution percentages, all together or in part, could account for the discrepancies in the compositions. For whatever reason, considering the similarities of the contribution of pond-reared fish to the 1976 year-class found in all three samples used in the 1980 assessment, the 1979 values found for the 1976 and 1977 year-classes are considered low.

Table 19. Mean length in mm and percent composition of Arctic grayling with circuli counts to and including first annulus of 11 or more and 10 or fewer, Delta Clearwater River, 1980.

Age	No. Circuli	Sample: Spring Monitoring * n	%	Mean Length	Index n	%	Mean Length	Creel n	%	Mean Length	Totals n	%
Age I	≤ 10	58	100	95	0			0			58	100
	≥ 11	0	0		0			0			0	
	Total	58		95	0			0			58	
Age II	≤ 10	24	45	151	3	30	193	4	57	207	31	44
	≥ 11	29	55	177	7	70	198	3	43	236	39	56
	Total	53		161	10		196	7		219	70	
Age III	≤ 10	16	53	195	3	19	217	7	37	244	26	40
	≥ 11	14	47	233	13	81	242	12	63	251	39	60
	Total	30		208	16		238	19		248	65	
Age IV	≤ 10	8	62	228	27	63	257	33	59	258	68	61
	≥ 11	5	38	253	16	37	280	23	41	277	44	39
	Total	13		238	43		265	56		266	112	
Age V	≤ 10	2	100	269	33	73	301	28	85	290	63	79
	≥ 11	0			12	27	327	5	15	299	17	21
	Total	2		269	45		308	33		293	80	
Total**		156			166			140			462	
	≥ 11	48	31		48	29		43	31		139	30

* Mile One Slough

** All totals and corresponding percentages include older age classes not shown.

While spring monitoring captures predomminantly immature fish, the index and creel samples are biased toward larger fish in which compositions of pond-reared grayling are generally less due to additional recruitment of "wild" fish. Also, the greater length of pond-reared fish in comparison to like-aged "wild" grayling would bias their representation in the first two age classes found in the latter samples. In Table 19 the compositions of pond-reared grayling in Ages II and III of the index and creel samples are higher than those found in the spring sample (with the exception of Age II in the creel sample), while numbers captured are less. Overall, the compositions found in these latter samples are similar to those found in the spring sample. Pond-reared grayling contributed to 29% of the index sample and 31% of the creel sample. This increase over the percentages found in 1979, 23% in both samples, is expected due to the older ages of the enhancement fish available to the sampling methods; Ages IV and V in 1980 versus only Age IV in 1979. With the three samples combined, pond-reared fish accounted for 30% of the Delta Clearwater grayling sampled in 1980, while in 1979 the percentage was 29%. This similarity between the two years of assessment is not unexpected considering that no fingerling plants were made in 1979 and thus no additional year-classes of pond-reared grayling were available.

Table 20 presents a summary of the contributions of four year-classes of pond-reared grayling to successive age classes captured in the Delta Clearwater since 1976 and of the numbers of each year-class stocked. Although the compositions of some age classes, namely Age Class II of the 1975 and 1977 year-classes, appear unusually low considering the higher percentages found a year later, the average compositions of pond-reared fish to Age Classes I to III are approximately 50%. At Age Class IV, the average percentage drops considerably and averages 28% for the two oldest age classes, IV and V. This indicates that additional recruitment to the system begins at Age Class IV. Although it is early for definite conclusions, these data suggest a different interpretation of the recruitment to the Delta Clearwater River's grayling population, of the natural stream-reared grayling.

With little or no reproduction documented in the Delta Clearwater River, Pearse (1974) suggested that Age III and IV grayling represented the first large recruitment to the system. The above data, along with the six years of data from spring monitoring, strongly suggests another interpretation, that the recruitment occurs in two stages. The first stage is the recruitment of Age Class I, while the second involves Age Class IV fish.

In 1979, 651 Age I grayling pond-reared for two summers in Big Lake were stocked in the Delta Clearwater River at the campground on Mile 8. They averaged 247 mm F.L. and all were tagged with Floy anchor tags and were given an adipose fin clip prior to release. With the exception of 371 Age I grayling (unmarked) stocked in 1977, all enhancement efforts had utilized fry or fingerlings.

A total of 32 recaptures of Big Lake fish were caught in 1980. During spring monitoring, seven Big Lake fish were captured, or 1.1% of those stocked the previous September. A similar percentage of grayling tagged

Table 20. Percent composition of Arctic grayling considered pond-reared captured in Delta Clearwater River, 1976-1980.

Year Class	Number Stocked	Age I		Age II		Age III		Age IV		Age V	
		N*	%	N	%	N	%	N	%	N	%
1975	9,100	10	60	70	31	42	52	116	29	80	21
1976	12,467**	46	76	59	46	170	41	112	39		
1977	6,684	307	53	397	28	65	60				
1978	7,209***	581	41	70	56		—		—		—
Average %			58		40		51		34		21

* Total sample size of each age class includes spring monitoring, index sampling and creel samples.

** n=371 stocked at Age I in 1977.

*** n=651 stocked at Age I in 1979.

one winter previously was found during 1979 spring monitoring when 1.7% of 884 grayling tagged in the Clearwater in the spring of 1978 were recaptured. Anglers returned 25 Big Lake tags in 1980, or 4% of the total tagged. This compares to similar percentages found in angler returns from grayling tagged the previous year in the Delta Clearwater; of grayling tagged in 1977, 6% were returned in 1978, of 1978 and 1979 tagged grayling, 5% of each were returned the following years. Sixteen of the 25 returns were known as to location caught. 81% (13) of these were caught within 1 mi downstream and 1/2 mi upstream of the tagging site. 19% (3) were caught within 3 mi upstream of the site.

Tagging studies conducted between 1960-1966 in the Delta Clearwater River indicated a strong tendency for the same grayling to be in the same spring-fed stream from one year to the next and suggests a strong homing tendency (Schallock and Roguski, 1967). As with the pond-reared fingerlings homing to spring areas (Ridder, 1980), the imprinting of the Age I pond-reared fish, as evidenced by the above returns, also appears to have occurred. Yet the question arises as to how many of those stocked returned.

Since 1977, all grayling greater than 200 mm have been tagged during spring monitoring at Mile One Slough. Delta Clearwater recaptures by anglers of fish tagged the same year have been remarkably similar in percentages during the four years, 1977-1980. Of fish tagged in 1977, 6% were returned in 1977, and similarly, 12% of the 1978 tags, 10% of the 1979 tags and 10% of the 1980 tags were returned the same year for a yearly average of 9.5% (Peckham and Ridder, 1979; Ridder, unpublished data 1980). If the assumption is made that tag returns in any given year represent 9.5% of the tagged fish available in the system, then the 25 Big Lake grayling represented by angler returns can be extrapolated to 263 fish being available at the start of the season. This number would then represent a 40% return of the 651 grayling originally stocked the previous fall.

Egg Source Investigations:

Investigations towards locating a local egg source for the enhancement program was limited to work on Caribou Creek, a tributary to Shaw Creek, and is described, in part, later in this report. Other than the fact that captures of in-migrating spawners were low due to their apparant habit of migrating during break-up, tag recoveries suggests the creek is an important spawning area for Richardson Clearwater River grayling.

Scale Analysis:

A technique based on scale pattern analysis has been applied and proven successful by the Commercial Fish Division, Alaska Dept. of Fish and Game, in the separation of Alaskan salmon stocks in mixed-stock fisheries (Krasnowski and Bethe, 1978). An endeavor was begun in 1980 to evaluate the technique in determining the stock origins of the Delta Clearwater River grayling populations. The statistical technique uses discriminant function analysis and is based on the concept that two (or more) stocks may differ slightly in the mean and distribution of values for circuli counts and radii, the two measurable characteristics of scale growth chosen as

variables. Since no single characteristic will allow identification with a particular stock due to value range overlap, the discriminant analysis uses a multivariate approach which combines variables to better identify stock membership. The analysis first requires measurements of variables of known stocks which provide the data for formulating the discriminant function. The variables measured from the mixed stock are then compared and classified by discriminant analysis into the various known stocks.

One reason for the success of the technique in salmon stock separation is the large geographical separation of discrete stocks, each of which produced variables that showed significant differences. Since this separation is absent in the stocks that may constitute the Clearwater grayling, and because of time and manpower constraints, the evaluation of the technique was limited to analyzing each scale variable from known spawning streams to see if significant differences existed among them that would warrant proceeding with the larger sample sizes needed for discriminant analysis.

Grayling scale samples were collected in the spring of 1980 from three known spawning streams within 27 mi of the Delta Clearwater; the Volkmar River, located 18 mi up the Tanana River, the Goodpaster River located 7 mi downstream; and Caribou Creek, a tributary of Shaw Creek located 27 mi downstream of the Clearwater's mouth. An attempt was made to standardize scale selection and measurement criteria as outlined in the techniques section of this report. Also, since scale growth is environmentally influenced, scales used for analysis were all from fish of the same year class as determined by the dominant age group in the samples, Age Class V.

The scale variables measured were the number of circuli to and including the annulus (NCI to NC5) and the distance between annuli (ID1-ID5) for each year of growth.

The analysis of variance for each variable by stream showed significant differences ($P < .05$) among the three group means (streams) for variables from the first 3 years of growth, NCI to NC3 and ID1 to ID3. There were no significant differences ($P > .05$) among the three group means for the variables from the last 2 years of growth.

To determine specifically which streams were significantly different for the first 3 years of growth, three commonly used multiple range tests were performed: the Duncan's, Student-Newman Keuls, and Least Significant Distance. All three tests gave the same results, which are presented in Table 21. All three streams (group means) were significantly different only in one variable, circuli counts from the first year of growth. In all other variables, (excepting ID3) only one stream was found significantly different from the others and, in regard to the set of variables for each year of growth, not always the same stream. Whether these differences in means are sufficient to fulfill the requirements of discriminant function analysis is presently being assessed by the Stock Separation Laboratory, Alaska Dept. of Fish and Game.

The distribution of values found for each variable upon which the function analysis is built, were seen not to be normally distributed in some cases

Table 21. Results of Multiple Range Comparison of group means.

VARIABLE	CIRCULI COUNTS			VARIABLE	ANNULI DISTANCES		
NC1	Goodpaster	Caribou	Volkmar	ID1	Goodpaster	Volkmar	Caribou
	(7.9)	(8.7)	(10.0)		(84.2)	(100.9)	(101.2)
NC2	Goodpaster	Caribou	Volkmar	ID2	Goodpaster	Caribou	Volkmar
	(9.9)	(10.2)	(11.4)		(69.5)	(81.7)	(88.3)
NC3	Caribou	Volkmar	Goodpaster	ID3	Caribou	Goodpaster	Volkmar
	(8.9)	(10.1)	(10.5)		(73.3)	(77.9)	(87.0)

Underlined group means showed no significant differences ($\alpha = .05$) for Least Significant Distance, Duncan's, and Student-Newman Keuls multiple range tests.

Table 22. Length frequency (in percent of daily sample) of 1,482 Arctic grayling captured by fyke trap (downstream set)* at Caribou Creek June 2-12, 1980.

Length (mm)	6/2	6/3	6/4	6/5	6/7**	6/9***	6/10	6/12	Total n	Total %
80-89			0.2	0.3					2	0.1
90-99		0.5	1.0	0.6					8	0.5
100-109	1.6	4.2	0.6	0.6			1.5	3.2	21	1.4
110-119	0.8	2.8	0.8	1.2			1.5	2.1	19	1.3
120-129	0.8	2.8	1.2						13	.9
130-139	4.8	11.2	1.0	0.9	2.4		0.8		40	2.7
140-149	3.9	5.6	3.0	2.4		2.7			41	2.8
150-159	3.2	3.7	2.2	2.4	2.4		0.8	1.1	34	2.3
160-169		2.8	1.6	2.1		2.7	0.8		23	1.6
170-179		1.4							3	0.2
180-189			0.4						2	0.1
190-199		0.9	0.6	0.9			1.5		10	0.7
200-209		0.5	0.2	0.6				4.2	8	0.5
210-219	1.6	0.5	0.8	0.6			6.9	3.2	21	1.4
220-229		0.5	0.4	1.2	2.4		9.2	13.7	33	2.2
230-239	1.6	1.4	1.2	1.2	2.4	24.3	14.5	9.5	53	3.6
240-249	4.8	1.9	3.9	1.5		8.1	13.0	14.7	69	4.7
250-259		2.3	3.7	3.0	9.5	13.5	17.6	21.1	86	5.8
260-269	1.6	1.9	5.7	7.9	2.4	27.0	13.0	12.6	101	6.8
270-279	6.3	2.8	9.8	10.0	7.1	2.7	11.5	5.3	120	8.1
280-289	4.8	4.2	5.5	8.5	11.9	8.1	1.5	3.2	84	5.7
290-299	4.8	6.0	8.1	5.8	2.4	5.4	3.8	3.2	90	6.1
300-309	11.1	5.6	10.4	10.1	7.1	2.7	1.5	1.1	119	8.0
310-319	12.7	7.9	8.3	7.3	11.9			1.1	105	7.1
320-329	3.2	9.8	8.7	8.8	4.8				100	6.7
330-339	3.2	7.0	5.9	7.6	7.1	2.7	0.8	1.1	80	5.4
340-349	11.1	3.7	4.1	4.3	11.9				62	4.2
350-359	7.9	2.3	3.0	4.9	7.1				49	3.3
360-369	3.2	2.3	4.7	2.7					42	2.8

Table 22. (Cont'd.) Length frequency (in percent of daily sample) of 1,482 Arctic grayling captured by fyke trap (downstream set)* at Caribou Creek June 2-12, 1980.

Length (mm)	6/2	6/3	6/4	6/5	6/7**	6/9***	6/10	6/12	Total n	Total %
370-379	1.6	0.5	2.0	1.8					19	1.3
380-389	4.8	1.9	1.0	0.6	2.4				18	1.2
390-399	0.8	0.9			2.4				4	0.3
400-409		0.5	0.2		2.4				3	0.2
n	126	215	508	328	42	37	131	95	1,482	
Water Temperature (°C)	8.5°	10°	11.5°	12.5°	13°C	13°	12°	12°		

* Additional captures by herding fish into trap, 6/3-6/12
** Muskrat hole in cod end.
*** Cod end open upon arrival.

and to overlap considerably in all of them. In themselves, they can pose difficulties in the accuracy of any classification by discriminant analysis and even possibly preclude it. Yet the probable causes of the aberrant distributions, such as inaccuracies of scale reading, small sample sizes, deficiencies in aging equipment and/or standardization methods, can be, in part, corrected. This fact and the results of the significance tests show that further evaluation and refinement of methods and criteria is warranted.

Post-Spawning Migration Investigations

Past studies of spring-fed streams, predominantly the Delta Clearwater River, dating back to 1952 have shown that little or no grayling spawning or overwintering of grayling occurs in these systems. Mark and recapture experiments conducted within the systems have documented the consistent homing of adult grayling to the Delta and Richardson Clearwater Rivers and suggest similar homing to spawning streams. They also suggest that the utilization of these streams as summer feeding areas is a result of a seemingly complex pattern of migrations of juvenile and adult grayling between a number of streams and river systems. The individual importance of these systems to the spawning and recruitment levels of the grayling populations of the spring-fed streams is not well known and yet is essential to their orderly management in the face of increasing angler and land-use demands. Toward this end, investigations of likely spawning streams were initiated in 1979 (Ridder 1980) and were continued during this reporting period, centering on the Shaw Creek and Volkmar drainages. (See Fig. 1 for locations in relation to spring-fed streams).

Tagging:

Caribou Creek, approximately 16 mi long, is the largest of nine named tributaries of Shaw Creek and is located 6 mi upstream of its mouth. Breakup and lingering anchor ice prevented setting of a fyke trap until May 14, 1980, at which time the creek had a temperature of 1°C. The trap was fished for upstream migrants for 8 days. Captures during this period totalled in excess of 151 grayling, of which 36 were greater than 200 mm FL and were given Floy anchor tags. Of these latter grayling, 20 were classed as prespawning adults, the rest immatures. The catch of in-migrants, the majority being lake chubs, juvenile grayling and least cisco, peaked on May 18 with the capture of hundreds and then declined rapidly to negligible catches on May 22, at which time the trap was reversed. The water temperatures during this period ranged from 2°C on May 18 to 2.6°C on May 22. It is conceivable that grayling bypassed the trap, since frozen undercut banks and bottom prevented complete blockage of the creek. It is also possible, due to the low catches of adult grayling, that the peak of the pre-spawning migration preceded the setting of the trap and occurred during breakup. Past studies cited by Tack (1980) stated that the majority of pre-spawning grayling begin migrating at water temperatures of 1°C.

The downstream trap was fished for 21 days from May 22 till June 12, at which time it was removed although out-migration of grayling was continuing. A total of 1,547 grayling was captured during this period, of

which 1,255 were greater than 200 mm and were tagged. Of these, approximately 900 were classified as mature adults. The first capture of spent adults (29) was made on May 25 and their captures peaked on June 4 at which time water temperature first exceeded 11°C. Between June 2 and June 12, 96% of the captures (1,482 grayling) were made and are summarized with daily catches, length frequencies and water temperatures in Table 22.

Considering the sizable numbers of juvenile grayling out-migrating with the adults, the general lack of grayling in the 170-210 mm range, which comprises the majority of Age Class III, is interesting and unexplained. As will be seen, recaptures of Caribou Creek tags were predominantly in the Richardson Clearwater River, where index sampling also showed a lack of Age Class III (only 2% of the catch). In the four previous years of indexing, this Age Class ranged from 11% to 17% of the catch and averaged 15% (Table 10). The observed male to female sex ratio of 335 grayling greater than 300 mm based on external sexual characteristics was 1.33 to 1.

From June 2 to June 12, recaptures of 45 tagged grayling were made during trapping. Three of these grayling had been tagged in the fall of 1979 in Shaw Creek downstream of Caribou Creek and one was tagged as a three year old in the Delta Clearwater in April of 1978. Nine captures were made of grayling tagged during the upstream trapping. The interval between their captures ranged from 8 to 24 days and averaged 18. Thirty-two grayling were captured twice during the downstream trapping and their time interval to recapture ranged from 0 to 8 days. Although the downstream trap was considered more successful at blocking the creek than the upstream trap, these latter figures do show some grayling (2% of total captures) returned upstream past the trap site, and might suggest that in-migration, to a certain extent, was continuing. Captures during the downstream set, most of which were made by herding the grayling into the trap with a seine, included 14 ripe adults (freely running eggs and milt) which comprised 1% of the total catch of 1,177 grayling made from June 2 to June 5.

The age frequency and length of 105 of the 1,291 grayling greater than 200 mm tagged in Caribou Creek are presented in Table 23. Age Class VI is predominant with 34% of the sample, followed closely by Age Class V with 28%. Lengths ranged from 212 mm to 420 mm and averaged 305 mm.

Additional captures of grayling before and during fyke trapping were made above and below the mouth of Caribou Creek by hook and line and totalled 59 grayling, all of which were tagged prior to release. One recapture of a fish tagged in Rapids Creek (Located approximately 21 mi above Caribou) in May of 1979 was made on May 8 at the mouth of Caribou. At this time bottom-fast ice was still very widespread in the creek.

Sampling of lower Shaw Creek during late May and early June was conducted in an effort to estimate total out-migration by the recapture of tagged fish but proved unsuccessful, with no recoveries being made. Three fyke traps were fished in the lower 2 mi of Shaw Creek for a total of 30 trap days between May 25 and June 5 when rising water levels precluded further trapping. The nets were constantly fouling with debris and fished poorly, with no grayling being captured. Seining the lower 1/4 mi of the creek on

Table 23. Age frequency and length of tagged Arctic grayling captured by fyke trap in Caribou Creek May 6, 30 and June 3, 1980.

Age Class	Number	Percent	Length (mm) Range	Mean
III	1	1	212	212
IV	13	12	216-262	233
V	29	28	248-336	283
VI	36	34	267-358	317
VII	19	18	318-367	342
VIII	6	6	330-403	371
IX	1	1	420	420
	105		212-420	305

May 27 and June 2 captured 27 grayling (4 and 23 respectively), of which only three were adults. They ranged in length from 218 to 297 mm with a mean of 251 mm. The lower 3 mi were sampled with an electrofishing boat on June 16 and only eight grayling were captured, all immature. Electrofishing is difficult along this section and captures are not indicative of abundance. Captures in the lower creek thus totaled 35 grayling, all of which were tagged prior to release.

In summary, grayling tagged during 1980 in Shaw Creek were 94; in Caribou Creek, 1,291; for a total of 1,385 for the drainage.

The Volkmar River, located 18 mi above the Delta Clearwater River and 45 mi above Shaw Creek (See Fig. 1), was sampled between May 25 and 27, 1980. The river is similar in length to Shaw Creek in flow but is shallower and wider in its lower 4 mi. Above Mile 4, the Volkmar River is considerably narrower than Shaw Creek. During the sampling period water temperatures at Mile 4 ranged from 12.5° to 14°C, which were considerably warmer than the temperatures recorded at Caribou Creek during the same period (4.2° to 8°C). Considering the experience at Caribou and the mean length of the Volkmar sample (276 mm versus 305 mm for Caribou) these temperatures would indicate that the peak of the post-spawning migration was past.

A total of 112 grayling was captured by hook and line and all were tagged prior to release. No ripe fish were noted and two were spawned out. The age frequency and length of 110 of these grayling is presented in Table 24. The predominant age group was Age Class V with 29% of the total, but it was followed closely by Age Classes III and IV with 26% and 25%, respectively. The length range of the sample was 200 to 366 mm and averaged 276 mm. The average lengths of Age III and IV grayling, 223 and 270 mm respectively, were considerably higher than those found in Caribou Creek for the same age classes, 212 and 233 mm respectively.

Tag Recoveries:

Recoveries of grayling tagged in 1979 (200) and 1980 (1,497) in the Volkmar River and Shaw Creek drainage (Caribou, Rapids, and mainstem Shaw Creeks) both from angler returns (n=62) and department recaptures (n=32) totalled 94, or 6% of the 1,697 tags given out. A summary of the recoveries is given in Table 25. With the exception of an early June trip to the Richardson Clearwater River (seven tags were recaptured), no special effort was made in 1980 at recapturing in the spring-fed streams outside of routine monitoring and creel census activities. Thus their respective recapture percentages given in Table 25 should not be viewed as skewed due to uneven effort.

All nine recaptures of Volkmar River grayling, 8% of the total number tagged, were made in the Delta Clearwater River by anglers. Six of these were recovered in early June, the rest in succeeding months. Their length ranged from 227 to 366 mm and averaged 312 mm and, of the nine, six were considered adults. The average length of Volkmar fish at time of tagging was 276 mm. The recapture rate is significant when past tagging studies in the Delta Clearwater River are considered. As suggested previously in the

Table 24. Age frequency and length of Arctic grayling captured by hook and line in the Volkmar River, May 25-27, 1980.

Age Class	Number	Percent	Length (mm) Range	Mean
III	29	26	200-253	223
IV	27	25	225-312	270
V	32	29	254-333	294
VI	14	13	274-340	313
VII	8		323-366	346
Totals	110		200-366	276

Table 25. Summary of 1980 tag recoveries of grayling tagged in the Shaw Creek drainage and Volkmar River in 1979 and 1980.

Water	Number Tagged	Number Recovered	Recovery Areas: Delta Clearwater N	%	Richardson Clearwater N	%	Clear Creek N	%	Salcha River N	%	Shaw Creek N	%	5 Mile Clearwater N	%
Shaw Creek:														
Caribou	1,291	75	2	3	62	83	2	3	3	4	4	5	2	3
Rapids*	22	2	0		1	50	0		0		1	50	0	
Main Stem**	272	8	1	13	2	25	1	13	1	13	3	38	0	
Volkmar River	112	9	9	100	0	—	0	—	0	—	0	—	0	—
Totals	1,697	94	12	13	65	69	3	3	4	4	8	9	2	2

* 1979 Tagging
** 1979 Tagging = 178
1980 Tagging = 94

recoveries of tagged enhancement grayling, an assumption can be made, based on an average of same year returns of tagged Delta Clearwater grayling, that tag returns by anglers in the Delta Clearwater represent 9.5% of the available tagged fish in the system. As such, the nine tags returned by anglers would represent 95 tagged grayling, or 85% of those tagged previously in the Volkmar River. Such numbers would strongly implicate the Delta Clearwater as a prime summer feeding destination for the post-spawning migration of Volkmar River grayling.

Of the 85 tags recovered from 1,585 grayling tagged in the Shaw Creek drainage (75 from Caribou Creek tagging), 65 or 76% of recaptures were made in the Richardson Clearwater River while three (3.5%) were recaptured in the Delta Clearwater, two by anglers and one during spring monitoring. Percent recaptures as individually derived from index and creel census activities on the Richardson Clearwater also surpassed the values found during like activities on the Delta Clearwater, but here they were based only on grayling tagged and recaptured within that system. Of the 170 grayling captured during the Richardson Clearwater index sampling, 10% represented Caribou Creek tags. The 1980 index samples in the Delta contained 2.7% Delta Clearwater tags of the 182 grayling sampled while the 1979 index gave 5% of 152. In regard to creel censusing, of the 418 grayling tabulated from the Richardson Clearwater, 7% or 28, were tagged grayling. From 2 years of creel data on the Delta Clearwater, 1979 data showed four tagged fish out of 147 censused, or 3%, while in 1980, 4% (10) of 225 grayling sampled bore tags. These Delta Clearwater percentages are due to 4 years of tagging effort totaling 2,325 grayling, of which, obviously, all were not available to the sample methods, yet together with the index percentages they give an idea on the number of tagged fish present during the Richardson Clearwater sampling. Also, a recovery effort on June 19 in the Richardson Clearwater captured seven tags. Four (44%) of nine fish captured by hook and line were tagged, as were three (8%) of 36 grayling captured by an electrofishing boat.

The recaptures of Shaw Creek fish, and especially those from Caribou Creek, show a decided downstream tendency of the out-migrating grayling. Of the 85 recaptures, 84% were made downstream; 65 tags were recovered in the Richardson Clearwater, 8 mi downstream, two in the Five Mile Clearwater (Jerry Hallberg, ADF&G, pers. comm. 1980) 20 mi downstream, and four in the Salcha River, 42 mi downstream. Of the six grayling, (7%,) captured upstream, three were recovered in the Delta Clearwater, 27 mi upstream and three in Clear Creek, 5 mi upstream. The remaining eight recaptures, (9%,) were made in Shaw Creek, of which four Caribou grayling were captured by anglers in late August.

A difference was also noted in the mean lengths (derived from tagging data) of the recaptured Shaw Creek grayling. The three Delta Clearwater tag recoveries averaged 247 mm and the four from the Salcha River averaged 276 mm. The mean lengths of recoveries made in the systems closest to Shaw Creek, all spring-fed, were those of mature fish. Clear Creek tagged fish had a mean length of 329 mm, Richardson Clearwater had 312 mm and Five mile Clearwater had recaptures averaging 322 mm.

In Table 26 are presented comparisons of age class frequencies and mean lengths between spring-fed streams and their associated bog-fed spawning streams as suggested by the tagging data. Both comparisons support the tagging data. The mean lengths of Age Classes III and IV in the Delta Clearwater and Volkmar River samples are correspondingly larger than those found in the Richardson Clearwater River and Caribou Creek. This may be the result of the influence of the enhancement program on mean lengths in regard to the Delta sample. For the Volkmar sample, the warmer water temperatures noted during sampling, in comparison to those found at Caribou Creek, could provide a better environment for growth, and enhancement fish could also have contributed to the Volkmar population.

In regard to frequencies, the two dominant age classes found in each system (Table 26) show the same similarities and differences. The Delta and Volkmar samples are similar, with the former showing Age Classes IV and V dominant and the latter giving Age Classes III and V, although only one percentage point separates the Age IV composition from the Age III. The Richardson and Caribou samples both show Age Classes V and VI as dominant.

Sampling methods and run timing may have affected the above comparisons, but generally they are considered to have balanced out. The Volkmar sample was affected the most with percentages skewed to younger fish by the hook and line sampling and the late stage of the outmigration. The Caribou sampling was by fyke trapping during the peak of the run and is considered representative of the length ranges susceptable to the July electrofishing that produced both spring-fed index samples. The creel sample was added to the Delta index data in the comparison because it too was hook and line and alone shared the uncharacteristically small difference between the mean lengths of Age Classes V and VI that is shown in the Volkmar figures. This difference amounted to 16 mm in the Delta creels and 19 mm in Volkmar's while in the other systems the differences ranged from 24 to 34 mm and averaged 27 mm.

Escapement Counts:

Escapement counts of coho salmon in the Delta Clearwater River and Clearwater Lake outlet were made on October 27 and 28, 1980 and are presented along with counts made since 1971 in Table 27. Escapement in 1980 totaled 3,946 in the main river and represents a 56% decline from the record escapement in 1979 of 8,970. The outlet escapement totalled 1,545, which is the highest tabulated to date. The previous high in the outlet was 1,500 salmon enumerated in 1975. The river escapement in 1980, as in prevous years, is a minimum value since it did not include those spawners utilizing the many spring areas located along the 17 mi censused.

Although no censusing has been conducted, general observations over the past few years indicate a growing interest among anglers, mostly military, in the coho run.

Discussion

Since 1978, population monitoring in the Delta Clearwater River by index sampling and creel censusing has shown a growing population of grayling.

Table 26. Age class comparisons of frequency (%) and mean lengths between spring-fed and associated bog-fed streams, Tanana drainage, 1980.

Water	Age Class III %	III Mean Length (mm)	IV %	IV Mean Length (mm)	V %	V Mean Length (mm)	VI %	VI Mean Length (mm)
Delta Clearwater* n= 313	11	243	<u>33</u>	266	<u>26</u>	301	19	321
Volkmar n=110	<u>26</u>	223	<u>25</u>	270	<u>29</u>	294	13	313
Richardson Clearwater n=152	3	225	16	251	<u>32</u>	298	<u>33</u>	322
Caribou n=105	1	212	12	233	<u>28</u>	283	<u>34</u>	317

* Index and creel sample combined, index sample only for the Richardson Clearwater.

** Underlined figures are dominant age classes in respective samples.

Table 27. Coho salmon escapement counts for the Delta Clearwater River and Clearwater Lake Outlet, 1971-1980.

Date	Delta Clearwater River	Clearwater Lake Outlet
Oct. 15, 1971	3,000*	ND
Nov. 9, 1972	630**	ND
Oct. 17 & 24, 1973	3,322	551
1974	ND	ND
Oct. 22 & 24, 1975	5,100	1,500
Oct. 21 & 22, 1976	1,920	460
Oct. 24 & 25, 1977	4,793	730
Oct. 25 & 26, 1978	4,798	570
Oct. 22 & 23, 1979	8,970	1,015
Oct. 27 & 28, 1980	3,946	1,545

* Estimate only. Counts from 1973 on were made utilizing an elevated platform.
** Count made late under poor conditions.

In 1980 the catch rates were the highest found in any of the 6 years of indexing and the 12 years of censusing. While the contribution of the enhancement program to four year-classes has positively affected the figures, other factors may also have contributed to the increase in numbers. These include the reduction in harvest and pressure since 1978, the unknown, but highly probable, contribution of the large fry plants of 1974 and 1975, and possibly, an increassed overwintering survival due to the previous 3 mild winters. Less obvious are the unknown factors that relate to the natural recruitment to this spring-fed system. These factors include the little understood behavior of grayling migrations between spawning, feeding, and overwintering areas.

The influence of the enhancement program, both fingerling (pond-reared) and fry plants, the variability of sampling methods, and the unknown migratory behavior have made it somewhat difficult to gauge the present condition of the grayling population in regard to natural recruitment. Prior to this recent 3 year increase in relative capture rates, there was a smaller, increase between the 3 years 1975 to 1977 followed by the decline in 1978, suggesting a cyclical pattern to grayling abundance. Yet, age compositions and length frequencies from both index and creel sampling during and following both periods showed a small but steady decline in older fish. What effect the known high harvests of 1977 through 1979, and presumably during the oil pipeline heyday of 1976, had on this decline and thus the population's spawning potential is unknown. The lack of comparative data and indices on the immature segment of the population that could show a decline in reproductive success, and thus recruitment to the system, preclude any determination. What is known is that pond-reared grayling were making up 50% of the youngest age classes beginning in 1976 and their recruitment to successive age clasees has undoubtably lessened the harvest of wild grayling to a point where in 1980 the decline of older fish was arrested.

If the percentages of pond-reared grayling are subtracted from the last two years of relative capture rates, the resulting figures still show an increasing population whose rate is similar to the earlier three year period mentioned above. How much of this is due to increased natural recruitment and how much is due to the success of the 350,000 fry planted in 1974 and 1975 is unknown.

The apparent success of the enhancement program and the high population indices found in 1980 should not obscure the fact that much information needed to intelligently manage the inevitable growth of the fishery is still unknown. This knowledge concerns the rate at which the system's natural grayling population renews itself and the factors which are most important in promoting or limiting this production.

With little or no reproduction occurring in spring-fed systems, their recruitment is entirely from other systems. Earlier studies implicated the Goodpaster River as one such system and suggested others as possibilities. The present study's investigations of the post-spawning migrations from Shaw Creek and the Volkmar River show that these bog-fed streams also play an important role as spawning areas for spring-fed grayling. In addition,

the study strongly suggests that their roles might be specific, at least for spawners, to individual spring systems. Not only will future studies clarify these relationships and gauge their importance to the Goodpaster River, but also, and perhaps most importantly, they will ideally describe the behavioral mechanism, whether innate, learned, or random, whereby grayling first "discover" the spring-fed systems. They will also provide the necessary knowledge for a sound appraisal of the fishery and intelligent management options for its future.

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